Chapter 11
NETWORK TRAFFIC PRIORITIZATION

1101 INTRODUCTION

The limited bandwidth available in maritime tactical networks is often insufficient to effectively transport the total offered traffic. Furthermore, the best-effort nature of IP networking can result in significant performance degradation when a network approaches overload. To minimise the operational impact of these effects, it is highly desirable to implement prioritization techniques to ensure that more important traffic is afforded an improved grade of service.

1102 AIM

The aim of this chapter is to address the requirement for traffic prioritization mechanisms and procedures.

1103 OVERVIEW

a. **Bandwidth Reservation.** Bandwidth may be reserved in the network on the basis of a number of criteria, including source address, destination address, source port, destination port, protocol type, or Type of Service (TOS) byte value. When enough features are selected (such as source address, destination address, and protocol type), bandwidth is reserved for a single flow. Bandwidth may also be reserved for a single class of traffic, perhaps indicated by the TOS byte value. Control information must be exchanged to set up any bandwidth reservation and, therefore, is a connection-oriented operation. Reserving bandwidth on a per flow basis provides a finer grade of control at the expense of an increase in overhead and more complicated network management. Reserving bandwidth for a particular traffic class reduces overhead but may require additional control at the network injection points so that the number of flows of a particular type do not overwhelm the available reservation. Reserved bandwidth is made available to other traffic when it is unused

b. **Differentiated QoS.**

(1) **Traffic Management.** Traffic arriving at a network node may receive access to transmission opportunities on the basis of its identifying characteristics (such as source address, destination address, and traffic class). This is often referred to as “priority.” Strictly speaking, the term priority implies a linear ordering on the arriving traffic types; however,

more sophisticated mechanisms for allocated transmission assets are available. Bandwidth allocation mechanisms, or schedulers include: (i) First In-First Out (FIFO), (ii) strict priority mechanisms, (iii) mechanisms which allocate transmission opportunities in an unequal fashion such as weighted round robin and Weighted Fair Queuing (WFQ). There are also other mechanisms, as well as various combinations. FIFO schedulers are the default mechanism for IP networks that provide undifferentiated service. All traffic is equal and the oldest traffic enqueued is served first. Strict priority mechanisms serve all traffic of higher priority waiting before any traffic of a lower priority is transmitted. Traffic requiring timely delivery, may be assigned a higher priority than traffic which is not delay-sensitive. Without any further constraints, traffic of the highest priority if arriving in sufficient quantity, may deny service to any other traffic. To prevent this, there is some merit in applying bounds on the amount of bandwidth allocated to each priority if strict priority scheduling is to be employed. WFQ and related schedulers can, through manipulation of the weights, provide relatively more service to one class over another without denying service to any. Thus, a form of "soft priority" is maintained.

(2) **Buffer Management.** Traffic waiting for transmission must be buffered. Just like transmission bandwidth, buffer space is a finite resource at each network node. In the presence of congestion, the buffers will fill and eventually traffic must be dropped. The default mechanism is 'tail drop' where traffic arriving at a node with full buffers is dropped. As traffic dropping is detected (e.g by higher layer protocols such as TCP operating at the source) the traffic injection rate can be reduced to help relieve the congestion in the network. Schemes besides 'tail drop' may be employed to manage buffer resources at a network node. Traffic which is time-sensitive and which has already expired may be dropped from the buffer to make room for a packet just arrived to a full buffer. Other mechanisms such as Random Early Drop (RED) begin to drop packets randomly as the buffers fill with the dropping probability increasing with buffer size. Higher layer mechanisms such as TCP are thereby given a chance to react more quickly to network congestion. A scheme which applies random early dropping to different traffic classes differently is called Weighted Random Early Dropping (WRED).

c. **Control Mechanisms.**

(1) **Admission Control.** Mechanisms that control the amount of traffic entering the network at injection points perform admission control. Such mechanisms are needed when bandwidth is reserved for a flow, for example, to insure that the offered traffic load does not exceed the

bandwidth reservation. It is possible that no admission control is performed, particularly for best-effort traffic.

(2) **Flow Control.** Flow control mechanisms act to control the amount of traffic entering the network from flows already admitted. Flow controls include those that are feedback-based and those that are not. Feedback-based controls rely on responses from destinations to indicate congestion. The most widely deployed of these is TCP. TCP uses acknowledgements of packet receptions from destinations to assess network congestion levels and control traffic injection appropriately. Examples of flow control mechanisms that do not rely on feedback are ‘source quench’ techniques and ‘traffic shaping’ mechanisms. In the former, explicit notification of congestion is sent back to sources with a request to limit their injection rates. In the latter, sources unilaterally enforce limitations on the traffic they offer to the network. Among traffic shapers, leaky bucket shapers are the most widely deployed.

1104 IMPLEMENTATION OF COMMANDER'S POLICY

a. **Operational requirements.** A commander will have a position on the relative importance of particular classes of traffic, and of specific information sources or destinations. This view will change as an operation develops. Therefore, the priority mechanisms must be able to be reconfigured as necessary to respond to these changes.

b. **Application requirements.** Some applications may require enhanced quality of service for effective operation - for example voice over IP. However, these applications may not be as critical as others to the success of the operation. Again the decision on the priority mechanisms to be used and priority level to be assigned must be derived from the commander's policy.

c. **Policy interpretation.** The selection of priority mechanisms and assignment of priority to specific classes of traffic and source, destination addresses will be co-ordinated by the primary NOC.

1105 IMPLEMENTATION

a. **Configuration.** Individual platforms will configure their network elements (e.g routers, traffic shapers) in accordance with direction from the Primary NOC.

b. **Monitoring.** The NOCs will monitor traffic flow. If necessary, the NOCs will vary the priority instructions to respond to changes in traffic demand.

1106 CONCLUSION

The use of prioritization is important to maintain effective operation in bandwidth-limited networks. The network manager is responsible for the management of the priority mechanisms to meet the commander's operational requirements.